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U1S S1884 S2316

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(54) Abstract Title
SUBMARINE COUPLING OF CONDUITS

(57) A fluid conduit 5 is connected to a well or other subsea installation by a first end connection (fig 4) and to a second well or other subsea installation 8 by a second end connection (fig 10). Seals 3, 21, 31, 40 at both connections are loaded with disc springs 19, 27 after seal surfaces are positioned with preinstalled elements. At the first connection after a lateral guide cone is mated with a post at the first well, the conduit 5 and its connector is swung to engage latching elements such as hooked arms 18 over a ridged element or shoulder of seal 3, subsequent release of a latch 20 releasing the springs 19 to load the seals 3, 21. At the other connection, a tension member 11 draws a connection member 38 with the conduit into engagement with a connection housing on the second well, the engagement being guided by a guide cone and tapered latch finger surfaces. An alignment member 26 is held in the connection housing by shearing elements which shear after full engagement of the alignment and connection members.

Fig 1

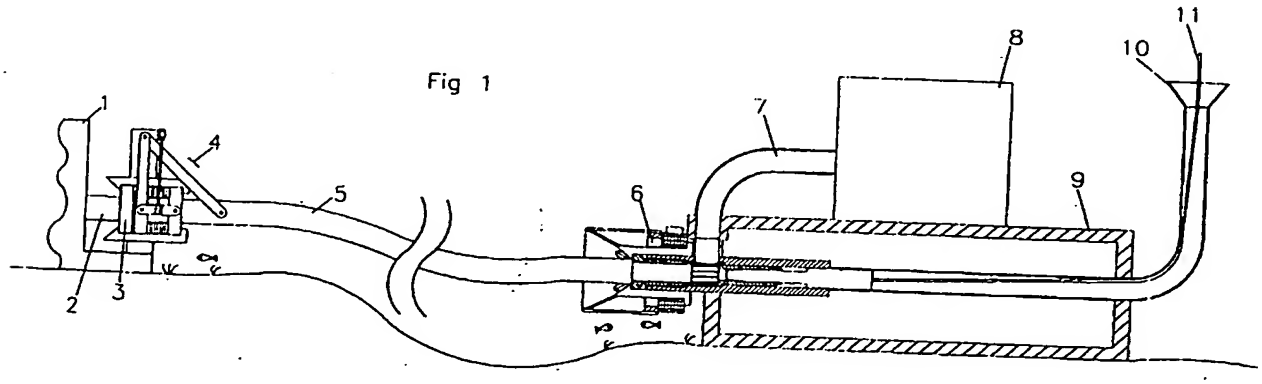

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Fig 1

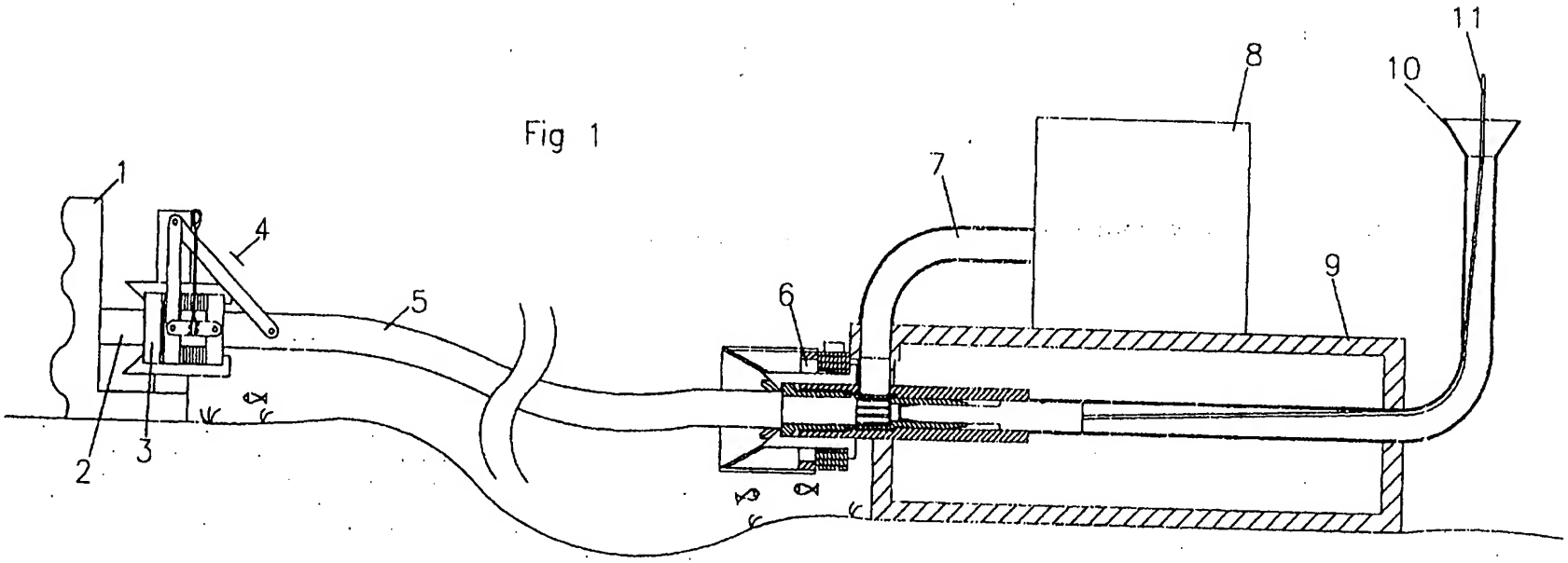

Fig 2

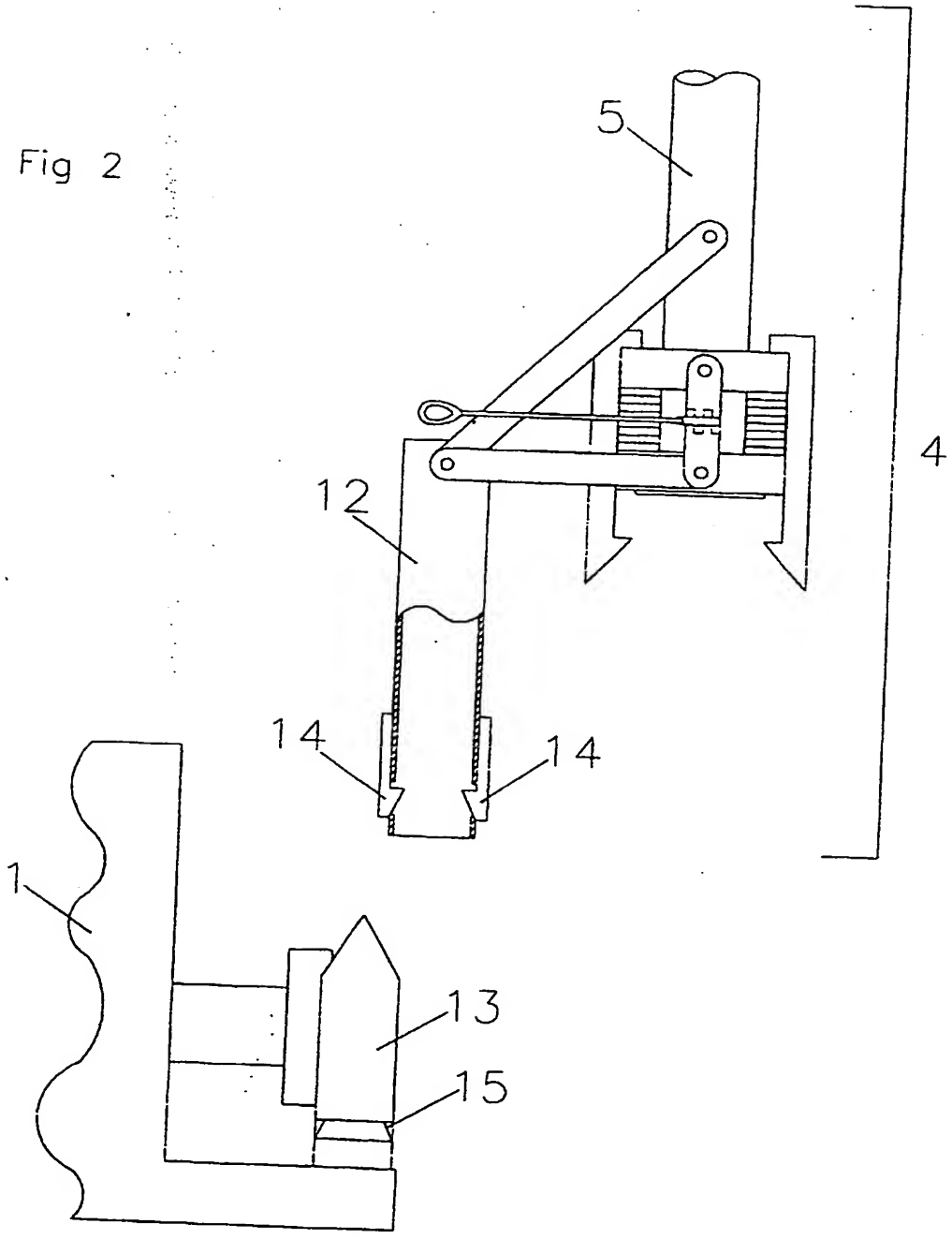

Fig 3

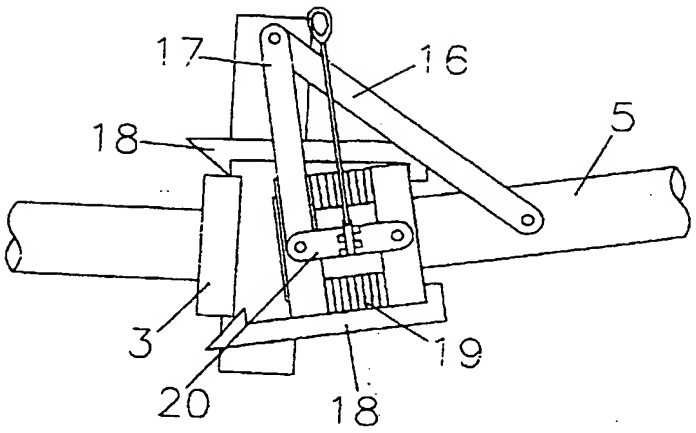

Fig 4

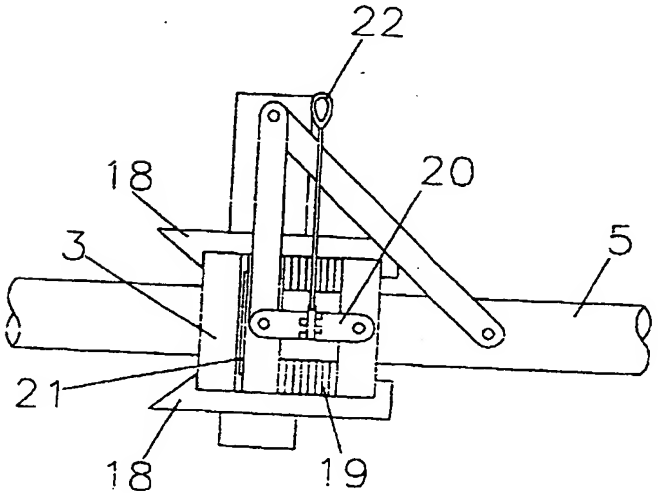

Fig 5

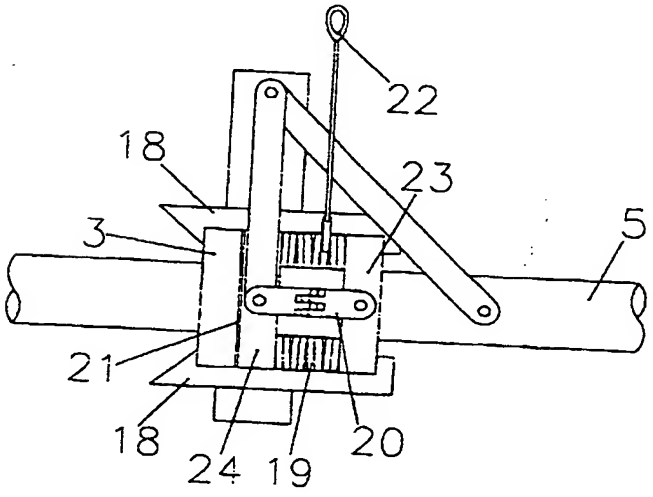

Fig 6

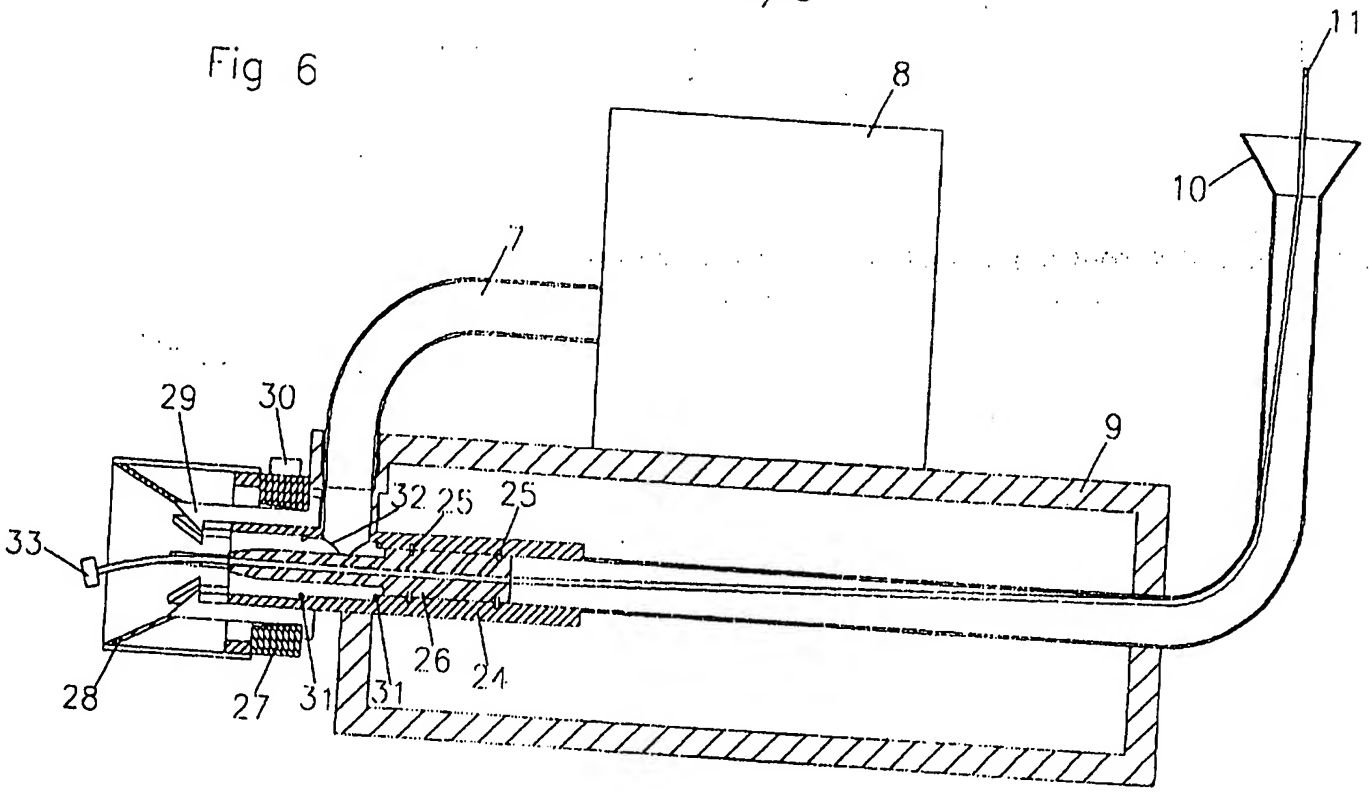
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Fig 7

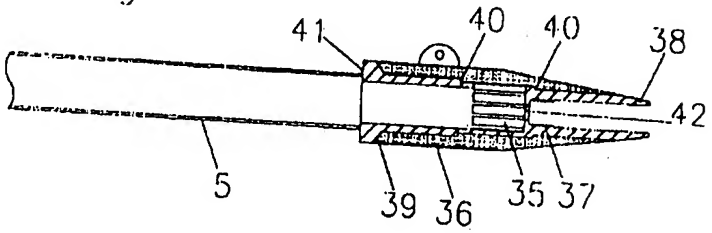
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Fig 8

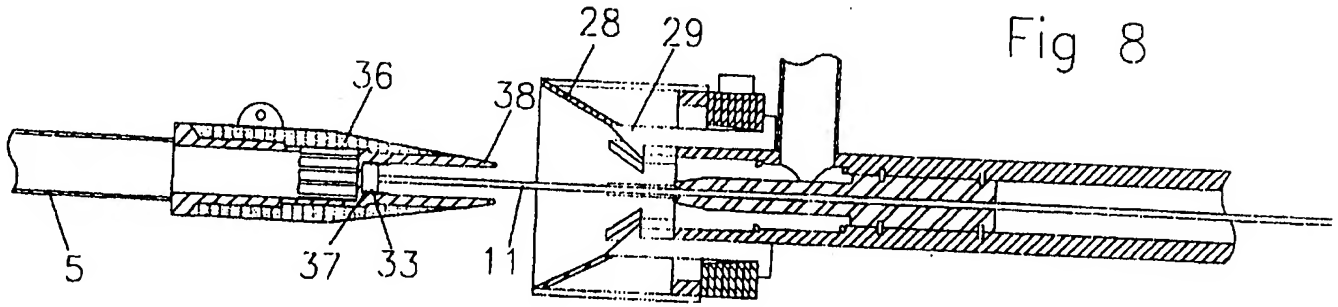


Fig 9

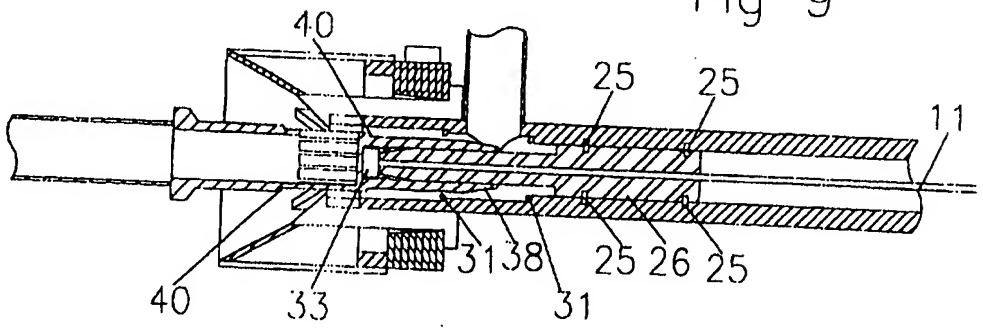
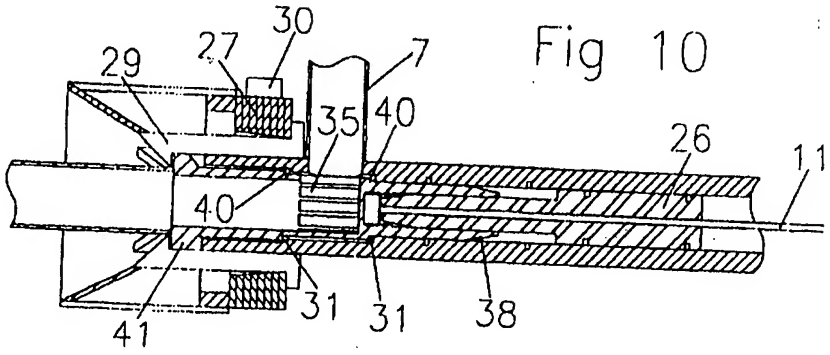


Fig 10



Method and Apparatus for Remote Connection of Fluid Conduits

This invention relates to coupling devices for underwater conduits, such as can be used for conveying various fluids between wells and other installations associated with the production of hydrocarbons from subsea fields.

Many such subsea developments incorporate wells spaced around a central facility requiring fluid conduits to be established between the wells and central installation. Other designs require the subsea wells to be connected directly to a surface facility which may be floating or fixed. In water to deep for diver operations, or in circumstances not suitable for diver operations, these fluid conduits must be connected, at one or both ends, remotely.

Hitherto, these connections have been effected in a two part operation requiring firstly the fluid conduit to be accurately located and secondly to be firmly clamped or otherwise held together with sufficient force to maintain competent, that is leak tight, seals. This normally requires use of one or more specialized tools and often the use of a vessel other than the drilling vessel required to drill and complete the well.

An object of this invention is to provide a connection system in which the connection members provide sufficient provision for alignment and clamping in the absence of other dedicated tooling. A portion of each connection is affixed to the ends of the fluid conduit and the remaining portion affixed to either the central facility or apparatus surmounting the well or other subsea installation.

The present invention provides a coupling device for underwater conduits comprising guide means attached adjacent to an end of a first conduit and firmly engageable with receptor means attached adjacent to an end of a second conduit, the engagement between the guide and receptor means defining a predetermined, substantially play-free path along which at least one of the ends of the first and second conduits is guided for movement towards the end of the other conduit into sealing abutment therewith.

With the present invention the predetermined, substantially play-free path which is defined by the engagement of the guide and receptor means ensures that the conduit ends are brought towards each other on a well-guided path with little risk of the conduit ends or the seal suffering damage.

Advantageously, the receptor means can include latching elements for latching onto the guide means to secure the receptor means onto the guide means; the latching elements further may be in the form of spring fingers.

Specific embodiments of the invention include a first end connection member and a second end connection member. The first end connection may be effected by lowering one of the conduits onto the other conduit, after which, the conduit which is lowered can be guided so that it undergoes pivotal movement for bringing the conduits into sealing abutment. Advantageously, the guide means can comprise a guide post, whilst the receptor means could comprise a hollow member, arranged to fit over the guide post.

The second end connection can advantageously be effected by movement of the conduits along a straight path due to the engagement between the guide and receptor means. In this regard, the receptor means can comprise a connection member on the second conduit, whilst the guide means could

comprise an alignment member guided within a connection housing of the first conduit. Further a flexible tension member can be attached to the connection member and extend through the alignment member and connection housing, for pulling the connection member into engagement with the alignment member. Shearing elements can be arranged in the connection housing so as to shear after full engagement of the connection member and the alignment member.

The first end connection member and the second end connection member can be used at either end of the underwater fluid conduit.

The first end connection requires the fixed subsea installation, or well, to be fitted with a passive guidance arrangement located in reasonable proximity to the termination of the fixed installation fluid conduit. Said termination is a circular member prepared with a suitable, plain, sealing surface.

As the fluid conduit is lowered vertically from the surface, with the first end connection attached, the connection is guided to the correct position by the passive guidance arrangements affixed to the fixed installation. Continued lowering causes the connection to be fixed to the installed structure. Further lowering causes the fluid conduit to move towards the seafloor. As the pipe rotates, the connection rotation is guided by a pivoting arm assembly to precisely position the connection, which carries the fluid conduit seal, adjacent and parallel to the seal preparation on the seafloor installation.

As the connection is being positioned adjacent to the seal surface, the latching fingers are distended to pass over the protruding edge of the seal preparation. At such time as the fluid conduit has rotated to the horizontal position, the latching fingers spring inwards to lock the connector in alignment

and close proximity to the seal preparation.

The final stage of effecting first end connection is to release the pretensioned disk springs which force the inboard and outboard seal surfaces with the seal carried on the outboard surface, into a stressed contact. This compresses the seal to complete the first end connection.

At the completion of the first end connection, the fluid conduit, which may be either rigid or flexible pipe, is lying on the seafloor and directed generally towards the location of the second end connection.

The second end connection is effected by pulling the connection member into a connection housing on the well or other subsea installation. Motive force is supplied by a tension member extending from the seafloor to the drilling vessel.

On the end of the second conduit is comprised of a protective cover, a receptacle for the remote attachment of the pull-in line, porting to accept flow, a blind end, and two circumferential metal seal surfaces.

The well, or other subsea installation at the second end connection is fitted with a guidance cone, alignment rod, circumferential seals, provisions for fluid ingress, and a tubular wire guide. The well or other subsea installation is prefitted with a length of flexible tension member extending through the alignment rod, which is shear pinned in position, and fitted at one end with a connection suitable for mating with the receptacle on the flexible conduit and on the other end with a connection suitable for mating with a tension member extending to the drilling vessel.

The second end connection is initiated by mating the flexible tension member coupling installed with the tree or other subsea installation with the receptacle mounted in the free second connection end of the flexible conduit. The coupling and receptacle are mated using a conventional remotely operated vehicle. The same vehicle connects the other end of the flexible tension member to the tension member extending to the dull vessel.

Tensioning the flexible tension member urges the fluid conduit towards the guidance member attached to the well or other subsea installation. As the connection nears the guidance member the protective cover is removed by the remotely operated vehicle and any required cleaning conducted.

As the fluid conduit is urged forward; the blind end with the flexible tension member connected contacts the alignment member. As force is increased, the pins holding the alignment member are sheared. Continued tension urges the fluid conduit and alignment member inwards to expose seal preparations and align porting on the connection and well or other subsea installation. When the connection and alignment have been urged forward to the limit set by the shoulder on the fluid conduit preparation, latching fingers which have been distended by the entry of the fluid conduit connection, move to the unilexed locking position. Release of the disk springs causes the seals housed in the well or other subsea installation to be compressed by the seal preparations on the fluid conduit connection and provide sufficient force to resist separating pressure loads.

The flexible tension member extending from the well or other subsea installation is then severed or otherwise disconnected by the remotely operated vehicle to complete the connection process.

A specific embodiment of the invention will now, be described by way

of example with reference to the following illustrated drawings; which are all cross-sectional views and in which

Figure 1 shows an arrangement of Flexible Conduit Connection System
Figure 2 shows a First End Connection being lowered
Figure 3 shows the First End Connection partially rotated
Figure 4 shows the First End Connection fully rotated
Figure 5 shows the First End Connection completed
Figure 6 shows a Preparation for the Second End Connection
Figure 7 shows an End of the fluid conduit for the Second End Connection
Figure 8 shows the Commencement of the Second End Connection
Figure 9 shows an Intermediate stage of the Second End Connection
Figure 10 shows a Further Intermediate stage of the Second End Connection

Referring to Figure 1, the connection system is comprised of a first end connection 4, mated to a seal preparation 3 and a fluid conduit 2 mounted on a well or other subsea installation 1. The fluid conduit 5 extends between the well or subsea installation 1 and other well or subsea installation 8. The well or other subsea installation 8 is mounted on a structure 9 housing a flexible tubular wire guide 10, through which passes a flexible tension member 11. Fluids passing from or to equipment 8 are directed through a conduit 7 to reach a second end connection 6.

Referring to Figure 2, the first end connection 4, attached to the fluid conduit 5, is shown being lowered over the well or other subsea installation 1

in such a manner that the guide cone 12 will land over a guide post 13. When the connector assembly 4 is fully down, spring latch fingers 14 will snap into groove 15 securing the assembly.

Referring to Figure 3, first end connection assembly 4 has rotated clockwise as fluid conduit 5 has been lowered. The trajectory is controlled by linkage bars 16 and 17. Spring latch fingers 18 are being distended over seal preparation 3. Disk springs 19 are held in the compressed state by a latch 20.

Referring to Figure 4, the first end connection 4 has rotated to the horizontal position, a fluid conduit 5 has been laid on the seafloor. Seal 21 is positioned close to seal preparation 3. Latch fingers 18 have snapped closed to secure the connection 4 to seal preparation 3. The spring disks remain fully loaded and are retained by latch mechanism 20 which is held in place by a securing member 22.

Referring to Figure 5, the seal 21 has been compressed by removal of securing member 22. Disk springs 19 urge collar 23 against latch fingers 18 compressing seal 21 between seal preparation 3 and seal carrier 24. The connection is now complete.

The preparation for the second end connection is illustrated by reference to Figure 6. The well or other subsea installation, 8, is connected to the base, 9, through a flowline 7. A connection housing, 24, is arranged such that ports 32 will coincide with matching ports in the fluid conduit connector.

Flexible tension member, 11, runs through tubular wire guide, 10, pass through alignment .member, 26, and terminates in latching connector 33. Alignment member 26 is maintained in position by shearable elements 25. Alignment member 26, seals 31, and flexible tension member 11, are installed

with the well or other subsea installation. Disk springs 27 are installed in the compressed state and maintained in ~this state by latch mechanism 30. Spring latch members 29 and guide cone 28 complete the preinstalled elements of the fluid conduit second end connection system.

Referring to Figure 7, the elements of the end preparation for the second end connection which is affixed to the fluid conduit are illustrated. Connection member 38 is permanently affixed to fluid conduit 5. Ports 35 align with fluid flowpath ports, 32, in the well or other subsea installation structure 9. Seal surfaces, 40, interface with preinstalled seals, 31, in the well or other subsea structure installation 9. The upset, 39, serves to urge latch finger, 29, over the connection member, 38, so the latch elements, 29, can seat on shoulder 41. Upset 39 also functions to stop inward motion as it impinges on seal carrier 24. Partition 42 isolates fluid conduit 5 internal flowpath from the nose of the connection member 38. The connection member 38 houses latch preparation, 37, which mates with latch 33 attached to the flexible tension member 11. Protective cover 36 shields seal surfaces 40 and prevents ingress of debris through ports 35 during completion of the first end connection and whilst fluid conduit 5 is being urged to close proximity to the second end connection preparation.

Referring to Figure 8, the second end connection system is illustrated prior to entry of the fluid conduit end preparation into the guide cone. The fluid conduit end preparation has been urged to the position shown by flexible tension member, 11, through mated latch, 33, and latch preparation, 37. Protective cover, 36, can be removed using a remotely operated vehicle. Matching profiles of latch fingers, 29, and the inner surface guide cone, 28, ensures centralization of connection member, 38, as it is urged further inwards by flexible tension member 11.

Referring to Figure 9, the second end connection is illustrated in an intermediate stage: Connection member 38 has been urged inwards by flexible tension member 11. Connection member 38 has been guided by alignment member 26 to avoid damage to seals 31 or seal preparations, 40. Latch 33 has been urged into contact with alignment member 26. Further urging will shear retaining members 25.

Referring to Figure 10, a further intermediate stage of the fluid conduit second end connection is illustrated. Connection member 38 has been urged inward by flexible tension member 11 and alignment member 26 has been displaced accordingly. Latch elements 29 have been first distended and subsequently returned to their original geometry behind latch shoulder 41. Seal preparations 40, are located against seals 31. Ports 35 have been aligned with the flow path 7 from well or other subsea installation. Release of latch 30 will allow disk springs 27 to load latch elements 29 to urge connection member 38 forward and compress seals 31 against seal preparations 40 to provide competent pressure enclosure and resist subsequent pressure loads. Severing flexible tension member 11 completes the second end connection.

Claims

1. A coupling device for underwater conduits comprising guide means attached adjacent to an end of a first conduit and firmly engageable with receptor means attached adjacent to an end of a second conduit, the engagement between the guide and receptor means defining a predetermined, substantially play-free path along which at least one of the ends of the first and second conduits is guided for movement towards the end of the other conduit into sealing abutment therewith.

2. A coupling device according to claim 1, wherein the receptor means includes latching elements for latching onto the guide means to secure the receptor means onto the guide means.

3. A coupling device according to any of the precedings claims, wherein the latching elements are spring fingers.

4. A coupling device according to claim 1, 2, or 3, wherein the guide and receptor means are engageable by lowering one of the conduits, onto the other conduit which is positioned on a subsea installation.

5. A coupling device, according to claim 4 wherein the conduit which is lowered, is guided for pivotal movement for bringing the conduits into sealing abutment when the guide and receptor means have been engaged.

6. A coupling device according to any of the preceding claims wherein the guide means comprises a guide post.

7. A coupling device according to claim 6, wherein the receptor means comprises a hollow member arranged to fit over the guide post.

8. A coupling device according to claim 1 wherein after engagement between the guide and receptor means the conduits are guided for relative movement along a straight path.

9. A coupling device for underwater conduits according to claim 1 or 8, wherein the receptor means comprises a connection member on the second conduit, and the guide means comprises an alignment member guided within a connection housing of the first conduit.

10. A coupling device according to claim 9, wherein a flexible tension member is attached to the connection member and extends through the alignment member and connection housing for pulling the connection member into engagement with the alignment member.

11. A coupling device according to claim 9 or 10 wherein the alignment member is retained in position within the connection housing by shearable elements arranged to shear after the connection member has been fully engaged with the alignment member.

INVESTOR IN PEOPLE

Application No: GB 0221937.6 **Examiner:** Darren Handley
Claims searched: 1-11 **Date of search:** 4 October 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): F4P (PL2, PL9)

Int Cl (Ed.7): F16L 1/12, 1/16; E21B 43/013

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2276696 A	(SHELL) - see connectors 22, 40 and guide 44 in figure 1	1, 4, 6, 7
X	GB 1189098 A	(NORTH) - see figure 2 and column 3, lines 8-20.	1, 2, 4-7
X	EP 0110441 A1	(BORMIOLLI) - see figures 1 and 2 and page 5, lines 8-21	1-3, 8-10
X	US 4086778 A	(LATHAM) - see figures 3 and 5 and column 5, line 27-column 6, line 38.	1, 2, 4, 8
X	US 3931670 A	(ARNOLD) - see figures 1 and 2 and column 2, line 33- column 3, line 2	1, 2, 8-11

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.